LITERATURE REVIEW

Empirical Verification of the Vector Consciousness Prediction (VCP)

Has nature already answered before we asked the question?

The Self-Experiencing Universe: A Manifesto for an Emergent Reality (Lis, 2025)
Waldemar Lis, with analytical assistance from Claude (Anthropic) — February 2026
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Point of Departure: A Question to Nature

The VCP Research Protocol formulated the following prediction: two biological systems with comparable phi but radically different vectors (s, i, r) should exhibit qualitatively different patterns of behavioral adaptation not explainable by phi alone. The candidate test systems are the honeybee swarm (Apis mellifera) and the cuttlefish (Sepia officinalis) — selected because of presumably comparable phi with radically different vector profiles: the swarm has very high integration (i) and low recursion (r); the cuttlefish has very high recursion (r) and moderate integration (i).

Before designing a new experiment, we asked: **do behavioral data already exist in the literature, and are they consistent with VCP?** The answer is surprisingly unambiguous.

Part I — The Cuttlefish: High Recursion in the Data

Vector profile predicted by HoTT-RO v2

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System B: Sepia officinalis
Predicted vector: (s≈0.57, i≈0.80, r≈0.85)
Form: high recursion, moderate integration
Structural metaphor: a subject without a collective
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High recursion (r) in relational ontology means: the system models itself, changes strategy after failure, operates on its own internal states as objects. Predicted behaviors: rapid individual adaptation, sequential trial-and-error, correlation between the capacity for delayed gratification and speed of learning new rules.

Finding 1 — Correlation of self-control with learning (Schnell et al., 2021)

Key study: Alexandra Schnell and colleagues (Proceedings of the Royal Society B, March 2021) tested the cuttlefish with a version of the 'marshmallow test' and a reversal learning task — learning a new rule after a change of conditions. Results:

- Cuttlefish maintained delayed gratification for 50–130 seconds, comparable to primates, parrots, and corvids.
- Cuttlefish that waited longer for better food learned new rules significantly faster after conditions changed. The correlation was very strong.
- The authors concluded: self-control and cognitive flexibility are coupled in cuttlefish — the same cognitive system underlies both.

Interpretation through VCP: this is a precise fingerprint of high recursion (r). A system that models its own future state (self-control = modeling the future self) and uses that model to change behavior (faster learning of new rules) — this is the operational definition of high r(κ).

FINDING 1 CONSISTENT WITH VCP ✓	Strong correlation between self-control and learning speed for new rules — the coupling of these capacities confirms high recursion (r). Predicted by VCP: cuttlefish adapts rapidly and individually through trial-and-error. Data: confirmed.

Finding 2 — Strategic flexibility and adaptation to rule changes (Billard et al., 2020)

Study: Billard, Schnell, Clayton and Jozet-Alves (Biology Letters, 2020) tested the cuttlefish's hunting flexibility. When food availability rules changed, cuttlefish immediately and individually switched strategy:

- When preferred prey was predictably available — the cuttlefish adopted a selective strategy (wait for better).
- When availability was unpredictable — the cuttlefish switched to an opportunistic strategy (take what is available).

- When conditions were reversed — the cuttlefish instantly switched strategy back. Adaptation was individual and rapid.

Key point: adaptation occurred through modeling the future (the cuttlefish predicted tomorrow's prey availability from today's data). This is not merely learning — it is planning based on a model of the system's own environment and needs. High recursion: the system models itself in relation to a future state of the world.

FINDING 2 CONSISTENT WITH VCP ✓	Rapid, individual strategy change after environmental rule change — exactly what VCP predicts for a system with high r(κ). No need for a collective, no quorum. The subject changes approach alone.

Finding 3 — Strategy change after failure (hunting studies, 2023)

Study: research on cuttlefish hunting tactics against moving prey (iScience, 2023) showed: hunting strategy directly depends on previous outcomes. After failure of the first attack type, the cuttlefish automatically switches to the second attack type. Not randomly — sequentially. The system registers its own failure and changes tactics.

Interpretation: this is minimal behavioral evidence of recursion in action. The system observes its own behavior as data and uses it to modify the next behavior. No partner, no network, no communicative dance required.

FINDING 3 CONSISTENT WITH VCP ✓	Sequential tactic change after failure — recursion in action. The system uses its own history as input to modify strategy. Individual, fast, without a collective.

Part II — The Honeybee Swarm: High Integration in the Data

Vector profile predicted by HoTT-RO v2

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System A: Apis mellifera (swarm)
Predicted vector: (s≈0.62, i≈0.90, r≈0.37)
Form: high network integration, low recursion
Structural metaphor: a collective without a subject
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High integration (i) in relational ontology means: no element of the system can be detached without loss of the whole's capacity. Decision emerges from the network, not from a center. Predicted behaviors: slow adaptation through redistribution of signals, decisions by quorum (not by an individual), no change of 'strategy as a whole' — instead, a change in the distribution of activity across the network.

Finding 4 — Decision by quorum, not by subject (Seeley & Visscher, 2003, 2004)

Classic studies by Thomas Seeley (Cornell University) — now standard behavioral knowledge about swarms. The mechanism of nest-site selection:

- Scout bees (a few percent of the swarm) independently explore different potential sites.
- Each scout 'advertises' its site through the waggle dance — the better the site, the longer the dance, the more recruits.
- The decision is made not when one bee 'decides', but when a sufficient quorum (typically ~15–20 bees) is simultaneously present at one option.
- No bee 'knows' how many bees are at other options — each responds only to local signals. The global decision emerges without global knowledge.

Key for VCP: there is no subject that 'decides'. There is a network of relations whose density at a certain point reaches a threshold and generates a decision. Integration is so high that no fragment of the network can be detached without changing the decision — and no fragment 'knows' for the whole. This is the operational definition of high i(κ).

FINDING 4 CONSISTENT WITH VCP ✓	Decision by quorum without a decision-making subject — fingerprint of high integration (i). No bee changes strategy — the network changes its distribution of activity. No individual modeling. Exactly what VCP predicts.

Finding 5 — Slow adaptation with dispersed signals (Seeley & Visscher, 2004)

Experiment: Seeley and Visscher tested what happens when the swarm has five identical, equally good sites instead of one. Result:

- With one site: quorum reached quickly (~79 minutes of dancing), decision efficient.

- With five identical sites: bees dispersed among options, quorum could not form for a long time (~244 minutes of dancing). Adaptation was proportionally slower.
- No bee 'understood' that the options were identical and made a shortcut decision. The system had to go through the full quorum process.

VCP interpretation: with dispersed stimulus, swarm adaptation is proportionally slow — because it depends on signal density forming above threshold. There is no shortcut mechanism through individual reasoning. This is the exact opposite of the cuttlefish, which in an analogous situation immediately switches to an opportunistic strategy.

FINDING 5 CONSISTENT WITH VCP ✓	Slow, dispersion-proportional swarm adaptation — without a shortcut mechanism through individual reasoning. Adaptation time depends on network density, not individual decision. Consistent with VCP: high integration, low recursion.

Finding 6 — Swarm intelligence as product of network, not subject (Seeley, 2010)

Thomas Seeley in 'Honeybee Democracy' (Princeton UP, 2010) documents a key property: the collective intelligence of the swarm is a product of disagreement and competition between groups of bees representing different options — not consensus or compromise. No bee models the whole. Each responds locally. The whole emerges from the network of local responses.

For VCP this is fundamental: the swarm has no recursion (r) because there is no subject that could model itself. There is no 'self' of the swarm. There is only the network. And this network makes better decisions than any individual — but more slowly, and without the ability to change 'strategy as a whole'. Strategy is encoded in the very architecture of the network, not in some decision center that could change it.

FINDING 6 CONSISTENT WITH VCP ✓	Collective intelligence without a subject — absence of recursion as a structural feature, not a deficit. The swarm cannot 'change strategy' because there is no subject to change it. Confirmation of low r(κ) as a property of form, not a limitation.

Part III — Summary: Data vs. VCP Prediction

Behavioral criterion	Honeybee swarm — data	Cuttlefish — data
VCP predicts: high i → collective; high r → individual	Collective ✓ (quorum without a subject)	Individual ✓ (subject changes tactic alone)
Adaptation after rule change	Slow, proportional to signal dispersion ✓	Instantaneous, by subject ✓
Response to failure	Redistribution of signals across network ✓	Tactic change by individual, sequentially ✓
Does 'someone' change strategy?	No — no one. The distribution in the network changes ✓	Yes — cuttlefish itself ✓
Knowledge transfer	Collective through dance (network-based) ✓	Individual through observation ✓
Self-control and learning	Not applicable for collective system	Strong correlation published in peer-reviewed data ✓

Verdict: What Nature Has Already Answered

VERDICT: VCP preliminarily confirmed by existing data

All six behavioral criteria examined are consistent with the VCP prediction. The cuttlefish shows the exact profile of high recursion: rapid individual adaptation, correlation of self-control with learning new rules, sequential tactic change after failure. The swarm shows the exact profile of high integration: slow, proportional collective adaptation, no decision-making subject, no mechanism for changing 'strategy as a whole'.

These patterns are qualitatively different — not merely quantitatively. The cuttlefish and the swarm are not at different levels of the same scale. They are at different vectors in (s, i, r) space. And their behaviors reflect this difference precisely.

The One Remaining Gap

Condition α of the VCP protocol — phi(A) ≈ phi(B) — remains empirically unconfirmed. Direct measurement of phi for the honeybee swarm as a collective system does not exist in the literature. IIT measures phi for coherent, localized neural networks — a swarm is a spatially distributed system, making standard phi measurement technically challenging.

What this means: VCP is preliminarily confirmed on the vector (s,i,r) side — behavioral patterns are consistent with the prediction. The gap concerns the phi side — we do not know whether phi(swarm) ≈ phi(cuttlefish). This is the only thing that requires new measurement. Everything else is already in the published data.

Specific question for IIT researchers (Massimini, Tononi):

How do you estimate phi for a collective system distributed in space (honeybee swarm)? Is this operationally measurable? If yes — one measurement closes gap α and VCP becomes a fully testable empirical prediction with a complete protocol.

References

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